THE DAILY FOOD RATION OF GREAT BRITAIN.[1]

SEVERAL estimates of the food supply of Great Britain, in whole or in part, have been published in recent years. But in none of these has a computation been made of the "foodstuffs" contained in the food, or of the energy which it furnishes to the human body. Yet these are the only standards which apply to all foods, whether solid or liquid, and taken together constitute the only applicable test by which the supply can be properly gauged. Thus we can only say whether the supply is sufficient, excessive, or deficient, when we know the quantities of protein, carbohydrate, and fat, and the amount of energy it provides per day to the consumer. Further, it is only when we have this knowledge that we can intelligently proceed to substitute articles of diet for others which may have been cut off or rendered scarce from any cause.

Such a survey of the food supply of Ireland has recently been made by the writer, and it seemed desirable that a corresponding inventory should be taken of that of Great Britain.

To do this, an independent estimate had in the first instance to be made of the total food of the country, both imported and home produced. This could only be done, with any degree of accuracy, for one particular year, that of the "Census of Production." So far the results of only one such census have been published, namely, for the year 1908. Accordingly the survey applies to this particular year; but there is every reason to suppose that it would apply equally well to any year of the last decade. The returns from which the quantities of the different food materials have been made are:—(1) Those of the Board of Trade, which give the imports and exports; (2) those of the Board of Agriculture, which give the home supplies; (3) those of the Departments of Fisheries of England, Scotland, and Ireland, which give the fish landed; and (4) lastly, those given in the Final Report of the First Census of Production, which supplement the others in necessary ways.

The Food Supplies.

These were collected under the following heads, namely:—(1) Cereal foods; (2) vegetables; (3) meat; (4) fish; (5) dairy products, eggs, margarine; (6) fruit; (7) other foods. It is only possible to give here short summaries of the estimates.

(1) *Cereal Foods.*—These include wheat flour and meal, oatmeal, rice, barley flour, maize meal, and "other farinaceous foods." The total supply is made up as follows:—

Net imports		Home produce		Total
67,506,951 cwts.	...	23,395,795 cwts.	...	90,902,746 cwts.

That is to say, 74 per cent. of our cereal food supply is imported and 26 per cent. home grown.

(2) *Vegetables.*—In this category are included potatoes, onions, tomatoes, cabbage and other green vegetables, carrots, beet, turnips, parsnips, celery, rhubarb, peas, and beans. The supplies are as follows:—

Net imports		Home produce		Total
16,360,000 cwts.	...	94,423,640 cwts.	...	110,783,640 cwts.

That is to say, 15 per cent. of our vegetables are imported and 85 per cent. home grown.

(3) *Meat.*—The supplies comprise beef and veal, mutton and lamb, pork, bacon, and hams, poultry, game, and rabbits, sausages and "offal." It is needless to say that all imported meat, including frozen, refrigerated, salted, and tinned has been included. The following are the quantities:—

Net imports		Home produce		Total
25,886,471 cwts.	...	24,577,994 cwts.	...	50,464,465 cwts.

Thus in round numbers 51·5 per cent. of the meat supply of Great Britain is imported and 48·5 per cent. home produced, Ireland being considered an importing country. Lard is not included in this list. It is given with imitation lard in Group 7, "Other Foods."

(4) *Fish: (a) Fresh, (b) Cured and Preserved.*—The fresh fish included herrings, cod, ling, haddock, mackerel, whiting, pollack, salmon, eels and congers, turbot, other flat and miscellaneous fish. Oysters and shell-fish were omitted. The cured and preserved fish included sardines, salmon, other sorts canned, and other sorts not canned. After making allowance for fish exported, the following are the net supplies:—

Fresh fish		Cured fish		Total
12,692,530 cwts.	...	591,802 cwts.	...	13,284,332 cwts.

(5) *Dairy Products, etc.*—This group includes butter, cheese, milk and cream, condensed milk, eggs, and margarine. The following are the quantities:—

	Net imports	Home produce	Total
Butter	4,834,722 cwts.	690,000 cwts.	5,524,722 cwts.
Cheese	2,207,459 cwts.	573,000 cwts.	2,780,459 cwts.
Milk and cream	63,710 gals.	802,439,000 gals.	802,502,710 gals.
Condensed milk	1,113,087 cwts.	—	1,113,082 cwts.
Eggs	24,609,266 gt. hunds. ...	9,494,084 gt. hunds. ...	34,103,350 gt. hunds.
Margarine	814,854 cwts.	881,000 cwts.	1,695,854 cwts.

There are reasons for believing that the quantity of home-produced cheese given in this list (as taken from the agricultural returns) is considerably below the actual consumption. The returns do not give any estimate of the farm produce consumed by the agricultural population. The home supply of eggs is also below the actual, since the returns do not include produce from farms below one acre. It is estimated that one-third of the total eggs are supplied by small poultry-keepers. Taking the quantities in the table above, it would appear that the home produce of butter from Great Britain, excluding Ireland, furnishes only 12·5 per cent. of the total supply, that of cheese 21 per cent., that of eggs 28 per cent. It is certain, however, that these two last estimates of home supply are well under the mark, and if the whole in each case were included, it is probable that the home supply of cheese consumed would be 35 per cent. and of eggs 42 per cent. of the total. Taking the home supply, however, even at these last values, it is not consoling that we have to rely so much on imports for what could apparently be produced without difficulty at home, in much larger quantities than at present.

(6) *Fruit: (a) Fresh, (b) Dried and Nuts.*—Of fresh fruit the returns give the quantities of apples, pears, oranges, lemons, bananas, plums, cherries, small fruit, other kinds and nuts. The following are the total supplies:—

Net imports		Home produce		Total
16,810,154 cwts.	...	6,044,250 cwts.	...	22,854,404 cwts.

Of this total, apples, oranges, and bananas make up three-fourths, and approximately in equal quantities. Of the home supply, apples make up two-fifths, but this does not include apples used for making cider.

The list of dried fruits and nuts includes currants, raisins, figs, dates, fruit preserved with sugar, almonds, coconuts, Brazil nuts, and walnuts. The total quantity amounts to 3,057,789 cwts., of which currants make up one-third and raisins one-fifth.

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[1] Abridged from a communication to the Royal Dublin Society, October 26, 1915, entitled, "A Calculation of the Food Stuffs and Energy of Great Britain's Food Supply."

(7) *Other Foods.*—In this category are included sugar, glucose, molasses, caramel, cocoa, chocolate, and olive oil. The following are the quantities :—

	cwts.		cwts.
Sugar	27,718,420	Cocoa and chocolate	549,050
Glucose (as dry sugar) ...	1,836,820	Lard and imitation lard	2,570,664
Molasses	2,199,515	Olive oil	82,800
Caramel ...	149,000		

The "Food Values" of the Supply.

When the food values—that is to say, the foodstuffs and energy values—of the previous supplies are reckoned out, it is found that for the year 1908 the population of Great Britain (40,200,000) was provided with the following amounts, of which the particulars are given in Table I. :—

Protein (lbs.)	Carbohydrate (lbs.)	Fat (lbs.)	Energy value (kilo-litre calories)[2]
2,419,166,767	14,175,125,520	3,231,594,600	44,826,291,359

and avoid duplication in allocating the supplies, it was assumed that those engaged in agriculture, together with their families, were self-provided with most of the foods grown on the farms. Accordingly, the foodstuffs and energy derived from the following list of farm produce were distributed, not amongst the whole population, but amongst those left after the agricultural population had been deducted. This list included :—(1) Vegetables (namely, potatoes, onions, cabbage, root crops, green peas, and beans); (2) dairy produce (namely, butter, cheese, milk, cream) and eggs; (3) oatmeal and barley flour; (4) poultry, game, and rabbits; (5) certain fruits (namely, apples, pears, plums, cherries, together with one-third of the small fruit).

The food values reckoned out for those articles and divided amongst the balance of the population left, after deducting for the agricultural population, are as follows :—

Protein (lbs.)	Carbohydrate (lbs.)	Fat (lbs.)	Energy value (kilo-litre calories)
728,697,739	2,835,356,188	1,083,718,635	11,492,106,905

TABLE I.—*The Foodstuffs and Energy Value of the Supplies.*

Food cwts.	Protein (lbs.)	Per cent. of total	Carbohydrate (lbs.)	Per cent. of total	Fat (lbs.)	Per cent. of total	Energy value Kilo-litre calories	Per cent. of total
Cereals	812,319,670	33·57	7,691,559,440	54·26	166,164,825	5·14	16,529,418,461	36·87
Vegetables ...	254,084,030	10·50	2,063,138,585	14·55	25,619,770	0·80	4,536,494,297	10·12
Meat	765,107,322	31·62	2,000,630	0·01	1,522,946,045	47·14	7,864,180,633	17·55
Fish	122,922,445	5·08	—	—	21,039,865	0·64	331,774,867	0·73
Dairy produce, etc.[3]	419,152,920	17·35	470,009,535	3·32	1,445,040,540	44·72	7,865,591,882	17·56
Fruit—								
(*a*) Fresh ...	14,390,455	0·59	285,095,825	2·01	7,031,610	0·22	597,242,464	1·33
(*b*) Preserved and nuts ...	12,368,895	0·51	166,588,475	1·17	17,603,390	0·54	458,507,190	1·02
Other foods ...	18,821,030	0·78	3,496,733,030	24·68	26,148,555	0·80	6,643,081,565	14·82
Total ...	2,419,166,767	100·00	14,175,125,520	100·00	3,231,594,600	100·00	44,826,291,359	100·00
Divisible into:								
(*a*) Agricultural	728,697,739		2,835,356,188		1,083,718,635		11,492,106,905	
(*b*) General ...	1,690,469,028		11,339,769,322		2,147,875,965		33,334,184,454	

To obtain a proper conception of the adequacy of the supplies, these totals have to be divided, not bv the whole population, but by the man-value of the population. It is obvious that children, according to age, require varying quantities of food—that is to say, different fractions of a man's ration. Likewise, women consume less food as a rule than men. Standards have therefore been fixed by which the food requirements of the women and children of a mixed population, can be reduced to man values. Of these, the standards given by Atwater are generally adopted, and are so widely known that it is unnecessary to repeat them here. They were followed, so far as the census returns allow, in determining the man value of the population of Great Britain, for the purpose of this survey, except in one particular. Atwater does not begin to give a full man's ration to boys or a full woman's ration (0·8 of a man's) until the age of seventeen is passed. In the computation here made, full rations were allocated to all above the age of fifteen. On this basis the population of Great Britain in 1908 corresponded to 30,955,000 men. But this number had to be further subdivided.

In the returns of agricultural produce, as already stated, no account is taken of farm produce consumed by the agricultural population. To meet this difficulty

The remaining quantities were distributed amongst the whole population per *man*. These are :—

Protein (lbs.)	Carbohydrate (lbs.)	Fat (lbs.)	Energy value (kilo-litre calories)
1,690,469,028	11,339,769,322	2,147,875,965	33,334,184,454

This mode of distribution—at best an approximation, but the most accurate at present available—involved a calculation of the agricultural population, and then its reduction to man value. Various estimates of the agricultural population have been made, some of which the writer considers excessive. An independent one, made for this survey, and based mainly on the census returns, placed the number in 1908 at 5,304,691, with a man value of 4,260,000. Deducting the latter figure from the total man value of the population—30,955,000—leaves a general population of 26,695,000.

A computation on these lines gives the following ration per *man* per day, for the population of Great Britain :—

	Protein (grms.)	Carbohydrate (grms.)	Fat (grms.)	Energy value (litre calories)
(*a*) Agricultural supplies	33·91	131·99	50·44	1,179
(*b*) General supplies ...	67·79	455·13	86·06	2,950
Total	101·70	587·12	136·50	4,129

The Daily Ration in Terms of Food.

The actual sources from which the foregoing foodstuffs and energy are derived are shown below. This list of foods and quantities may therefore be taken as the British daily ration, provided by the total supply, as given in available returns:—

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[2] The ordinary calorie used for expressing the energy value of a food represents the heat required to raise a litre of water from 15° to 16° C. This proved an inconveniently small unit for expressing values of the magnitude of a nation's food supply. Accordingly a unit 1000 times as great, and called here the kilo-litre calorie, is used for the most part throughout.

[3] Eggs, margarine, lard and imitation lard are here included in this group.

TABLE II.—*The Daily Food Ration of Great Britain.*

	Quantity (oz.)	Protein (grms.)	Carbo-hydrate (grms.)	Fat (grms.)	Energy value (grms.)
Flour and meal ...	14·55	32·80	311·10	6·80	1,476
Meat...	8·17	30·91	0·10	61·34	699
Fish	2·11	4·83	—	0·83	29
Vegetables: Potatoes	15·54 4·74	11·44	95·22	1·15	461
Dairy products:					
Milk and cream ...	0·66 pt.	16·65	221·54	45·25	588
Condensed milk ...	0.37 oz.				
Butter	1·02 ,,				
Cheese	0·51 ,,				
Lard and margarine	0·08 ,,	0·90	—	17·18	162
Eggs (2·94 per wk.)	0·74 ,,	2·46	—	1·93	29
Sugar, ordinary ...	4·40 ,,	0·23	139·30	—	572
Glucose and treacle	0·64 ,,				
Fruit, fresh	3·85 ,,	0·60	12·17	0·29	56
Fruit, preserved and nuts	0·48 ,,	0·43	6·68	0·70	41
Cocoa and chocolate.	0·09 ,,	0·45	1·01	0·67	13
Olive oil	0·01 ,,	—	—	0·36	3
Total		101·70	587·12	136·50	4,129

That is to say, the daily supply of food per *man* in Great Britain as above shown consists in round numbers of 14½ oz. of flour and meal, 8⅙ oz. of some form of flesh meat, 2 oz. of fish, 15½ oz. of potatoes, 4¾ oz. of other vegetables, two-thirds of a pint of milk, 1 oz. of butter, ½ oz. of cheese, ⅓ oz. of condensed milk, ⅔ oz. of lard and margarine, less than half an egg, 3⅘ oz. of fresh fruit (such as apples, pears, oranges, bananas, etc.), ½ oz. of dried fruit, $\frac{1}{10}$ oz. of cocoa, and $\frac{1}{100}$ oz. of salad oil.

But the published returns do not include the full home supply of cheese, eggs, rabbit, meat, or poultry, and probably also of cabbage used as human food. Additions to cover these omissions bring up the daily ration of meat to 8⅓ oz., of vegetables to 5¼ oz., of cheese to ⅝ oz., and the supply of eggs to 3·34 per week. The food and energy value of the ration would thus be increased as follows:—

Protein (grms.)	Carbohydrate (grms.)	Fat (grms.)	Energy value (litre calories)
104·47	587·84	138·94	4,169

As a fair estimate, it would be safe to say that the gross values of the British daily food ration per *man* do not exceed the following, namely:—

Protein (grms.)	Carbohydrate (grms.)	Fat (grms.)	Energy value (litre calories)
105	590	140	4,190

The marked feature of this ration is the large quantity of fat. But a careful revision of all the sources of this foodstuff, and of the calculations upon which the total supply is based, only confirms the estimate. Moreover, the fat supply in the German daily food ration before the war, as published by the Eltzbacher Committee, is almost identical, and the ration as a whole corresponds closely with that of Great Britain. The German ration in the report of the committee is expressed in quantities per head of the population, and includes alcoholic drinks, which are left out of the present survey.

Deducting for these, and giving the quantities per *man* per day, the gross values of the ration are as follows:—

Protein (grms.)	Carbohydrate (grms.)	Fat (grms.)	Energy value (litre calories)
117·6	660·5	136·3	4,428

The values of the German ration are for food as produced or delivered at the port; those of the British ration, as here stated, are in the main the same. To get the values as purchased by the consumer, a deduction has to be made for loss in distribution. This is placed between 5 and 10 per cent. Taking it as 7·5 per cent., and deducting from the highest of the estimates, the values of the British ration "as purchased" are:—

Protein (grms.)	Carbohydrate (grms.)	Fat (grms.)	Energy value (litre calories)
97·13	545·8	129·5	3,875

On comparing the British ration with accepted standards for moderate and hard work, it is found to give an energy value between the two. Dr. Langworthy places the values "as purchased," for moderate work, at 115 grams of protein, with sufficient other food to give 3800 litre calories. Taking the mean of four standards for hard work, namely, Playfair's for English labourers, Gautier's for French labourers, Atwater's for American operatives, and Colonel Melville's for soldiers on active service, the values come out to be: protein 145 grams, with sufficient other food to give 3900 calories. The protein in these standards is considerably higher than in the British ration. But there is no disadvantage—probably the reverse—in reducing the intake of protein provided the calorie value is kept up.

Dealing with the possibility of economy in the British ration, it will be seen that the values arrived at—assuming this survey to be correct—afford no evidence of excessive supply or of waste of food. The quantity provided per man per day is just sufficient for fairly hard work. The distribution is, of course, never even; the well-to-do get somewhat more than their share, the poor less.

But the great bulk of the population—the middle classes—appear to get no more than enough to do their work, and any reduction in the total food energy would endanger the health and strength of the working man.

Where, then, is economy to come in? The answer is: (1) in substituting vegetable foods, rich in protein, such as oatmeal, peas, lentils, and beans, for part of the more costly meat supply; (2) in teaching those who have not this knowledge the great value of such foods, and how best to cook them; and (3) in the exercise of strict economy and thrift to prevent waste and make the fullest use of every article of diet. These lessons I find are admirably inculcated in a pamphlet issued by the Board of Education, entitled "Economy in Food" (Circular 917). The results of this inquiry strongly emphasise them.

A change in the directions indicated would have other useful effects also. Demand and supply reciprocally act on each other; demand creates supply, and supply influences consumption. This applies just now, more particularly, to agricultural produce. There can be no doubt, and the fact needs reiteration, that *the arable land of the United Kingdom is not used to the best advantage in the matter of food production.* The writer has elsewhere[4] pointed out that the yield of food per statute acre is far less if employed to graze cattle and sheep than if used for growing grain, potatoes, or other vegetable foods. A calculation based on average results placed the yield per statute acre in beef or mutton at 260 oz. of protein and 290,000 litre calories of energy. The same area of land furnishes, in potatoes seventeen times as much protein and thirty times as much food energy; in oats eighteen times as much protein and fourteen times as much food energy; in wheat nineteen times as much protein and fifteen times as much food energy; in beans twenty times as much protein and nine times as much food energy; in peas ten times as much protein and four times as much food energy. Even in the yield of flesh meat the advantage is on the side of tillage. More stock can be fed and more meat produced by tillage. This is particularly shown in the case of pig meat. The produce of an acre of land provides, as pork or bacon, nearly five times as much protein and seven times as much food energy as if the land were used for grazing sheep or cattle.

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[4] "Food Values." Dublin: Dollard and Co., 1915.

W. H. THOMPSON.

HARVARD CONTRIBUTIONS TO PHYSICS.

VOL. II. of "Contributions from the Jefferson Physical Laboratory of Harvard" consists of reprints of eighteen papers which have appeared in the *Physical Review* and elsewhere during the years 1913–14. The research work which these papers represents was largely aided by the Coolidge and other funds for original research. Dr. Bridgman's high-pressure work occupies a large share of the volume. We have already noticed in these columns his paper on the technique of high-pressure experimenting. From his other papers in the present volume it seems now clear that the melting points of solids continue to rise as the pressure is increased to 12,000 kilos. per sq. cm. at a rate which shows no sign of the existence of maximum melting points or of any critical points in the melting-point curves. Of the late Prof. B. O. Peirce's work on the magnetisation of short cylinders we gave an account some time ago. Prof. H. C. Hayes shows that a rate-flow meter for fluids depending on the difference of pressure at the centre and side of a vortex can be constructed to give results correct to within 1·5 per cent. Mr. J. Coulson describes an apparatus for reproducing and measuring very short intervals of time depending on the difference of time an elastic wave takes to pass from a point near the middle of a rod to the two ends. Prof. Lyman has investigated the arc and spark spectra of mercury in the region from $\lambda = 1870$ to 1270, and has found that the positions of the lines do not agree with the predictions of Hughes from photo-electric data. In the theoretical field, Prof. Hall shows that the phenomena of thermo-electricity seem to be due to free electrons, but that electric conduction seems to a large extent independent of them. Prof. Webster concludes that the phenomena of radiation, of optics, and of photo-electricity can be explained, without discarding the classical dynamics, by the aid of the Parson magneton—a ring of electrons of diameter one-tenth that of a hydrogen atom moving round its axis with the speed of light. From these short notes it will be seen that the volume constitutes a record of research of which any university may be proud.

FORTHCOMING BOOKS OF SCIENCE.

AGRICULTURE.

John Bale, Sons, and Danielsson, Ltd.—Green Manures and Manuring in the Tropics, including an Account of the Economic Value of Leguminosæ as Sources of Foodstuffs, Vegetable Oils, Drugs, etc.," P. de Sornay, translated by F. W. Durlacher.

ANTHROPOLOGY AND ARCHÆOLOGY.

John Lane.—The Magic of Malaya, C. W. Harrison. *Longmans and Co.*—The Folk-Element in Hindu Culture: a Contribution to Socio-Religious Studies in Hindu Folk Institutions, Benoy Kumar Sarkar. *Macmillan and Co., Ltd.*—The Tribes and Castes of the Central Provinces of India, R. V. Russell, assisted by Rai Bahadur Hira Lāl, four vols., illustrated. *The Medici Society, Ltd.*—Central American and West Indian Archæology, T. A. Joyce, illustrated ("Handbooks to Ancient Civilisations"). *The Oxford University Press.*—Miscellaneous Babylonian Inscriptions, Prof. A. T. Clay; Observations on the Mussulmauns of India, Mrs. Meer Hassan Ali, edited, with introduction, by W. Crooke; The Beginnings of Buddhist Art, A. Foucher, translated by L. A. and F. W. Thomas; Origin and Meaning of some Fundamental Earth Structures, C. P. Berkey; Contributions to the Ethnology of the Salish Tribes, J. A. Teit; The Drama of Savage Peoples, Dr. L. Havemeyer. *Kegan Paul and Co., Ltd.*—Earliest Man, F. W. H. Migeod.

BIOLOGY.

F. Alcan (Paris).—L'Evolution des Plantes, N. Bernard. *John Bale, Sons, and Danielsson, Ltd.*—The Animal Parasites of Man, Dr. H. B. Fantham, Prof. J. W. W. Stephens, and Prof. F. V. Theobald, partly adapted from Dr. Max Braun's "Die Tierischen Parasiten des Menschen" (fourth edition, 1908), and an appendix by Dr. O. Siefert. *The Cambridge University Press.*—The Evolution of Reptiles, S. W. Williston; The Problem of Individuality in Organisms, C. M. Child; The Living Cycads, C. J. Chamberlain; Mechanics of Delayed Germination in Seeds, W. Crocker; The Problem of Fertilization, F. R. Lillie ("University of Chicago Science Series.") *J. M. Dent and Sons, Ltd.*—Name this Flower, Prof. G. Bonnier, translated and edited by Prof. Boulger, illustrated; The Rambles of a Canadian Naturalist, S. T. Wood, illustrated. *C. H. Kelly.*—British Fungi, and How to Identify Them, J. H. Crabtree. *Longmans and Co.*—British Birds, written and illustrated by A. Thorburn, 4 vols., vols. iii. and iv; South African Botany, F. W. Storey and K. M. Wright. *John Murray.*—Vegetable Fibres, Dr. E. Goulding; The Study of Animal Life, Prof. J. A. Thomson, new edition, illustrated. *The University Tutorial Press, Ltd.*—Practical Botany, Dr. F. Cavers, new edition. *Whittaker and Co.*—Some Recent Researches in Plant Physiology, Dr. W. R. G. Atkins. *John Wiley and Sons, Inc. (New York), and Chapman and Hall, Ltd.*—Laboratory Manual of General Microbiology, of Bacteriology, Hygiene, and Pathology, W. Giltner; Seeding and Planting in the Practice of Forestry, J. W. Toumey; Landscape Gardening as Applied to Home Decoration, new edition, illustrated.

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